I CLAIM:

1. A method of accurately positioning a substrate within a semiconductor processing apparatus, the method comprising:

loading a reference substrate onto a robot;

moving the robot with the reference substrate to a nominal robot position at a positioning station;

recording reference substrate data from a sensor at the positioning station while the robot is at the nominal robot position;

loading a process substrate onto the robot;

moving the robot with the process substrate to the nominal robot position at the positioning station;

recording process substrate data from the sensor at the positioning relating to the process substrate at the positioning station;

calculating a substrate drift of the process substrate relative to the reference substrate; and

compensating for the substrate drift in subsequent robot movement of the process substrate.

2. The method of Claim 1, wherein the sensor comprises a proportionate sensor providing an output value proportionate to a portion of a sensor beam unblocked by the substrate.

3. The method of Claim 2, wherein the positioning station comprises at least two proportionate sensors, the reference substrate data and process substrate data including output from each of the at least two proportionate sensors.

4. The method of Claim 3, wherein moving the robot with the reference substrate to the nominal robot position comprises conducting an iterative process until each of the at least two proportionate sensors are partially blocked by an edge of the reference substrate.

5. The method of Claim 3, further comprising, after moving the robot with the process substrate to the nominal robot position, an iterative robot movement process if necessary until each of the at least two proportionate sensors are partially blocked by an edge of the reference substrate.

6. The method of Claim 5, further comprising compensating for the iterative robot movement process while compensating for the substrate drift.

7. The method of Claim 3, wherein each of the at least two proportionate sensors are partially blocked by a trailing edge of the process substrate when the process substrate data is recorded.

8. The method of Claim 3, wherein each of the at least two proportionate sensors are partially blocked by a leading edge of the process substrate when the process substrate data is recorded.

9. The method of Claim 8, further comprising recording additional process substrate data when each of the at least two proportionate sensors are partially blocked by a trailing edge of the process substrate.

10. The method of Claim 9, wherein each of the at least two proportionate sensors are partially blocked by a leading edge of the reference wafer at a second nominal robot position when the reference substrate data is recorded, and further comprising recording additional reference substrate data when each of the at least two proportionate sensors are partially blocked by a trailing edge of the reference wafer.

11. The method of Claim 9, further comprising comparing a substrate drift calculated with the process substrate data against a substrate drift calculated with the additional process substrate data to determine presence of a substrate notch/flat at either of the leading or trailing edges.

12. The method of Claim 9, comprising:

calculating first drift parameters from the process substrate data recorded while the leading edge of the process substrate partially blocks each of the at least two proportionate sensors; and

calculating second drift parameters using the additional process substrate data recorded while the trailing edge of the process substrate partially blocks each of the at least two proportionate sensors.

13. The method of Claim 12, further comprising determining presence of a substrate notch/flat at either of the leading or trailing edges by determining whether a difference in the first drift parameters and the second drift parameters is above an allowable threshold.

14. The method of Claim 13, wherein the allowable threshold value is about 0.5 mm.

15. The method of Claim 12, wherein calculating the substrate drift comprises averaging the first drift parameters and the second drift parameters.

16. The method of Claim 3, wherein calculating the substrate drift comprises calculating drift parameters (*x, y*) representing lateral and longitudinal drift of the process substrate relative to the reference substrate.

17. The method of Claim 16, wherein calculating drift parameters (*x, y*) of the process substrate from the nominal wafer position comprises

calculating linear deviation Δ of an interception point of the process substrate edge relative to the reference wafer interception point for each of the at least two proportionate sensors;

calculating a lateral spacing *f* of each sensor from an axis of robot translation; and

calculating the drift parameters (*x, y*) from the linear deviations Δ, *f* and the substrate diameter *d*.

18. The method of Claim 17, wherein the lateral spacing *f* of each sensor is calculated using the following formula

$$f = \tfrac{1}{2}\sqrt{d^2 - (p_i - p_i')^2}$$

wherein $(p_i - p_i')$ is equal to a distance the substrate has moved along a direction parallel to the sensor longitude between a position in which a leading edge of the substrate intercepts the sensor and a position in which a trailing edge of the substrate intercepts the sensor at the same point.

19. The method of Claim 17, wherein, for each sensor,

$$\Delta = \frac{l_{max} - l_{min}}{V_{max} - V_{min}}\left(V_{ref} - V\right)$$

where l_{max} and l_{min} represent maximum and minimum sensor lengths blocked by the wafer, V_{max} and V_{min} represent the output value of the sensors when l_{max} and l_{min} are blocked, V_{ref} indicates the sensor output value when the wafer is at the nominal position,

and V indicates the sensor output value when the process substrate is at the nominal wafer position.

20. The method of Claim 19, wherein (x, y) are calculated using the following formulae:

$$x = \frac{1}{2}\left[f_L - f_R + \sqrt{\left(\frac{d}{s}\right)^2 - 1}\left(\Delta_L - \Delta_R + \sqrt{\left(\frac{d}{2}\right)^2 - f_L^{\,2}} - \sqrt{\left(\frac{d}{2}\right)^2 - f_R^{\,2}} \right)\right]$$

$$y = \frac{1}{2}\left[-\sqrt{\left(\frac{d}{s}\right)^2 - 1}\left(f_L + f_R\right) + \left(\Delta_L + \Delta_R + \sqrt{\left(\frac{d}{2}\right)^2 - f_L^{\,2}} + \sqrt{\left(\frac{d}{2}\right)^2 - f_R^{\,2}} \right)\right]$$

$$s^2 = \left(f_L + f_R\right)^2 + \left(\Delta_L - \Delta_R + \sqrt{\left(\frac{d}{2}\right)^2 - f_L^{\,2}} - \sqrt{\left(\frac{d}{2}\right)^2 - f_R^{\,2}} \right)^2$$

wherein d represents the wafer diameter, Δ_L and Δ_R are the wafer deviations of the two sensors, and f_L and f_R are the lateral spacing from left and right sensors, respectively, to an axis of robot translation.

21. The method of Claim 20, further comprising determining the nominal robot position by:

moving the robot with the reference substrate to the nominal robot position;

rotating the reference wafer through an angle θ_g;

calculating an x_g displacement resulting from rotating through the angle θ_g using the formula for x in Claim 20; and

obtaining a value g by substituting the value of x_g obtained into the following formula:

$$g = \frac{x_g}{\sin\theta_g}$$

22. The method of Claim 21, wherein compensating for substrate drift comprises changing the position of the robot supporting the process wafer in accordance with the following formulae:

$$\Delta\theta = \sin^{-1}\left(\frac{-x}{\sqrt{x^2 + (g+\delta+y)^2}}\right)$$

$$\Delta R = g + \delta - \sqrt{x^2 + (g+\delta+y)^2}$$

where ΔR indicates a compensating change along the translation axis, Δθ indicates a compensating change in rotational position, g is calculated from the formula of Claim 21, (x, y) are calculated from the formulae of Claim 20 and δ represents a change in robot position from the positioning station g when compensation is made.

23. The method of Claim 1, further comprising determining the nominal robot position for use in compensating for the substrate drift by intentionally inducing a drift, measuring the induced drift and calculating reference wafer position based upon the measured induced drift.

24. A system for accurately positioning a workpiece during movement thereof, the system comprising:

a positioning station comprising at least two proportionate sensors aligned parallel to one another, each sensor producing an output inversely proportional to a sensor beam area blocked by the workpiece; and

a computer instructing a robot to move the workpiece into a position at the positioning station wherein at least two of the sensors have their sensor beams partially blocked by an edge of the workpiece, the computer programmed to

read outputs from the sensors,

calculate a positional drift relative to an expected workpiece position, and

adjust a robot position to compensate for the positional drift.

25. A method of orienting at least one sensor for determining a position of a substrate, comprising:

placing a sensor within a processing system in an initial orientation;

moving the substrate to a plurality of substrate positions;

collecting data from the sensor at the plurality of substrate positions; and

adjusting the sensor from the initial orientation based upon the data collected by sensor.

26. The method of Claim 25, wherein moving the substrate comprises moving the substrate exclusively in a single direction of translation among the plurality of substrate positions.

27. The method of Claim 26, wherein moving the substrate comprises translating the substrate upon a robot end effector.

28. The method of Claim 26, wherein adjusting the sensor from the initial orientation comprises aligning the sensor to have an axis parallel to the direction of translation.

29. The method of Claim 28, further comprising aligning a second sensor to have an axis parallel to the direction of translation, thereby aligning the sensor with the second sensor.

30. The method of Claim 25, wherein the sensor comprises a proportionate sensor providing output proportionate to an area of a sensor beam unblocked by the substrate.

31. The method of Claim 30, wherein moving the substrate to a plurality of substrate positions comprises:

in a first iteration, moving the substrate to a first position wherein a front edge of the substrate blocks a back portion of the sensor beam and moving the substrate along a direction of translation to a second position wherein a trailing edge of the substrate blocks a front portion of the sensor beam, the back portion and the front portion equaling a total area of the sensor beam;

in at least a second iteration, moving the substrate along the direction of translation to a different set of first and second positions wherein the back portion and the front portion equal the total area of the sensor beam.

32. The method of Claim 31, wherein adjusting the sensor comprises orienting the sensor such that data collected from the sensor indicates a value that is equal for each iteration.

33. The method of Claim 31, wherein adjusting the sensor comprises calculating, for each iteration, a value proportionate to an orthogonal distance from an axis of the direction of substrate translation to a point of the sensor bordering the front portion and back portion.

34. The method of Claim 33, wherein adjusting the sensor comprises rotating the sensor such that the value is equal for each iteration.

35. A method of orienting a sensor beam to have a longitudinal direction of the beam parallel to a translation direction of a substrate positioning device, the method comprising:

(a) determining a general translation direction of a robot end effector, to which the substrate is attached for transport;

(b) installing a sensor system comprising a transmitter, which produces the sensor beam with a cross-section length and thickness, wherein the length is substantially larger than the thickness and having a direction along the length that is defined as a longitudinal direction, and a receiver which measures a maximum analog voltage, v_{max}, when a full intensity of the sensor beam reaches the receiver and also measures a linearly decreasing voltage as the sensor beam is increasingly blocked by the substrate and smaller portions of the sensor beam reach the receiver;

(c) placing the substrate onto the end effector;

(d) moving the substrate to a centering station at a position p_i where the sensor beam is blocked, in part, by a leading edge of the substrate, and the receiver indicates a voltage, v_i;

(e) moving the substrate to a position p_i' along the translation direction where the sensor beam is blocked, in part, by a trailing edge of the substrate, and the receiver indicates a voltage of v_i', such that $v_i' = v_{max} - v_i$;

(f) repeating steps (d) and (e) for at least $i = \{1, 2\}$;

(g) calculating a value f_i for all i, where f_i is a function of a distance moved between positions p_i and p_i'; and

(h) rotating the sensor system if f_i is not constant within a predetermined tolerance for all i and repeating steps (d)-(h).

36. The method of Claim 35, wherein the substrate is a circular semiconductor wafer.

37. The method of Claim 36, wherein f_i is proportional to a lateral distance from the

38. The method of Claim 37, wherein $f_i = \frac{1}{2}\sqrt{d^2 - (p_i - p_i')^2}$ where d is a diameter of the wafer and $(p_i - p_i')$ is the distance moved between positions p_i and p_i.

39. The method of Claim 35, wherein the sensor beam has a length of about 10 mm and a thickness of about 1 mm.

40. The method of Claim 35, wherein the receiver maximum voltage, v_{max}, is about 5 volts.

41. The method of Claim 35, wherein multiple sensor systems are installed and steps (c)-(h) are repeated for each sensor system until all sensor systems have their longitudinal axis parallel to the one another.

42. The method of Claim 41, wherein the sensor systems are installed in step (b) with their longitudinal directions approximately parallel to the general translation direction.

43. The method of Claim 35, wherein step (f) comprises repeating steps (d) and (e) for at least $i = \{1, 2, 3, 4, 5\}$.

44. The method of Claim 35, wherein the predetermined tolerance is ±0.05 mm

45. The method of Claim 44, wherein the predetermined tolerance is ±0.005 mm.